smothered in detail. But to know what the earth is we must know what the earth has been. The story of the planet and the life it has sustained is prerequisite to a complete understanding of the earth sciences and of the life sciences as well.

As an educational instrument geology has the advantage of concentration and homogeneity. If, like mathematics or physics, it lacks the warm human interest, the applications of geography to human life, yet its current is not shoaled by division into numerous channels. If either physical geography or geology must be omitted from our crowded high-school courses, let it not be geology, the more fundamental, the more coherent, the more educative of the two.

What then should be the place and sequence of the earth sciences in secondary programs? Can they be arranged so as to include the outlines of all, and yet without repetition? It seems to me that certain changes are desirable to secure this end. I should like to see nature study so enlarged in the lower grades that the common physiographic processes early become familiar. There is an evident trend toward the enlargement of the physical geography with which our advanced geographies are now introduced. To me this seems the proper place for the study, but while the treatment of all essential forms and processes which bear directly on the life and work of man may be expanded, all matter irrelevant to this should here be omitted. I should like to see the areal and descriptive geography which follows so enlarged that it will take in the American high-school the place it holds in the German *Realschulen* and *Gymnasia*. Each geographic unit, each region of our country, each national domain may then be treated thoroughly in all departments of the science. With the physical environment everywhere made basal, we need not fear to give anthropic geography the largest possible place. It may be that much might be brought in which a strict definition of geography would exclude. But with due selection of material, with grasp of principles, with historic perspective, and especially with a thorough knowledge of physiographic controls, the wise teacher of geography can afford to take as his motto, I consider nothing alien to myself that relates to man. The extension of anthropic geography, however, cannot be brought about by discussion, or criticism, or the writing of text-books. It must come in precisely the same way as has the extension of physical geography—by scientific research. It awaits the masters who will some time do for the sciences relating to man what geology is doing for the science of land forms.

The proper place, then, for physical geography is a place preliminary to the areal geography which applies its principles and consequences to special regions. To review it later as a separate study would then seem unnecessary. Instead, let the course in the earth sciences be concluded by meteorology and geology. The earth sciences may thus be so closely articulated as to form the vertebral column of secondary scientific instruction. So close is their touch with human life, so thorough and comprehensive is their discipline, so simple, so natural, so rational, and so real is their culture, that their extension only awaits their connection into one continuous line of study.

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PROFESSOR FRAAS ON THE AQUEOUS VS. ÆOLIAN DEPOSITION OF THE WHITE RIVER OLIGOCENE OF S. DAKOTA.

A SPECIAL expedition of the United States Geological Survey into the Bad Lands of South Dakota was led by N. H. Darton, of the Survey, assisted by J. B.

Hatcher, of the Carnegie Museum; with the party was also Professor Eberhard Fraas, of Stuttgart. The object of the expedition was to secure exact geological data for the monograph 'The Titanotheres,' now in preparation by Professor Osborn. The matters of chief importance were: first, to determine the mode of deposition of these beds in view of the arguments recently brought forward by Matthew, Davis and others that they were æolian rather than aqueous in origin; second, to determine the exact stratigraphical levels upon which the different types of skulls and skeletons have been found, verifying and extending the very careful records made by Mr. Hatcher between 1886 and 1888 while collecting for the United States Geological Survey, under Professor Marsh.

Mr. Darton will prepare the formal report of the geological results of this expedition, including a map showing the extent and exact thickness of the beds in different portions of this region. In the meantime it is interesting to learn the opinions of a highly trained European geologist, Professor Fraas, upon the nature of these beds, expressed in an informal letter to Professor Osborn:

"I take this opportunity to briefly present my opinion on the origin of the Oligocene of the Bad Lands. So far as I have been able to observe the beds during the past eight days, one can by no means speak of their structure as æolian in the ordinary sense of the word. It is quite possible that wind-transport may have taken some part in their formation, but the strata themselves appear to me to have been chiefly laid down under water. We ought, I think, to take into consideration the following series of different petrographical and structural conditions:

"(1) The *Titanotherium Beds*, which constitute the base of the Oligocene, I take to be the deposit of a slowly flowing river, which emptied in the broad delta upon the level stretches of the Ft. Pierre [Middle Cretaceous]. This view is supported by the occurrence of large boulders of ground-conglomerate at the base of the *Titanotherium Beds*, as well as by the frequent embedding of sand and gravel in the clays and marls. The current was manifestly very gentle and laid down a continuous substratum, resulting in cross-bedding in the sands and gravels. Against the dune-structure (æolian) testify the widespread layers of sand banks, often very thin, the heavy gravel and the fine lamination of the clays. The current was directed from west to east, and corresponding to this the thickness of the gravel and sand layers diminishes as we pass eastwards. (2) It is very difficult to determine the origin of the overlying *Oredon Beds* [Middle Oligocene, 560 feet in thickness]. We must take the following facts into consideration: (*a*) The entire material has undergone a strong metamorphosis; the sandy, non-calcareous clays were formerly marls rich in calcareous matter, the concretionary structure of the harder banks and the texture of the material giving positive evidence on this point. (*b*) Certain layers were very rich in gypsum and barite; both minerals are now represented only in pseudomorphs of chalcedony, formed out of gypsum and barite. Probably there was united with the tendency to gypsum formation, a similar tendency to rock-salt formation, but I have found no evidence of this. (*c*) The structure of the layers: In the *Lower Oreodon Beds* concretions are abundant, which originally were composed of clays rich in calcareous matter. (This is the principal layer of *Testudo* and of the mammals.) Here are also thin banks of clear limestone, now strongly silicified; land and fresh water snails are found here (*Helix* and *Limnæa*); sand layers are not found here. The very massive *Middle Oreodon Beds* are splendidly laminated and

horizontally banded; that is, the colors change regularly from clear to dark. At times, in the darker portions are observed harder layers of limestone rich in clay. In the lowest layers of these middle beds we find the greatest abundance of gypsum and pseudomorphs. A layer of compressed smooth lenses of sandstone frequently appears (*Metamynodon* and *Protoceras* sandstone). Where the lenses are thin and smooth the lamination is even, where the layers are thicker, with coarser material, we observe cross-bedding. The *Uppermost Beds* of the White River Oligocene are altogether different. They are composed of very uniform material (often of volcanic ashes according to Dr. Darton), containing numerous nodules and round concretions; there are also large concretions, with the turtles again abundant, in fact, arranged quite differently from the Lower and Middle Beds. This sedimentation is manifestly of æolian character.

"When we put together all these observations to form a conclusion as to the structure of these beds we come to the following result: At the beginning [of the Oligocene] a broad, slowly flowing stream spread out towards the east and formed a broad, widespread and uniform delta landscape (Titanotherium Beds); this even, swampy land was dry during the dry seasons, but was flooded in every high-water period; besides the water the wind frequently took part in the transport of the dust and materials. The concretions are structures of the percolating waters (Lower Oreodon Beds, numerous land mammals). Now followed a long period in which this region was flooded by a shallow rather than deep lake. The inflow of water did not exceed the evaporation, and so through the varying concentration there was a precipitation of the dissolved materials which gave rise to the banded layers. In the same manner the gypsum and barite in these layers is explained. Stronger currents poured in sand, which accumulated in low elevations (Middle Oreodon Beds). At last there came a widespread æolian condition in the form of loess, which spread out upon the gradually retreating or evaporated levels of the lake."

CHARLES ANTHONY SCHOTT.

WITH the death of Charles Anthony Schott, Assistant, United States Coast and Geodetic Survey, closes a most useful life, led by a remarkable man.

He was born at Mannheim, Baden, Germany, August 7, 1826, and began his studies very early, learning to read before reaching four years of age, and it is stated that his work began as a small boy. He graduated from the Polytechnic School at Carlsruhe with the degree of C.E. in 1847.

He came to the United States in 1848 and entered the United States Coast Survey, thus beginning his life of enthusiastic work in the advancement of science by the solution of the problems which confronted this organization created to obtain accurate charts of the extension coasts of the United States. He was immediately attached to the Computing Division in the office of the Survey where he remained until October, 1849, when he was assigned to the schooner *J. Y. Mason* and steamer *Walker* as hydrographic draftsman. In July, 1850, he returned to the Computing Division and on July 1, 1852, he was regularly appointed to the position of computer. From time to time he acted as chief of the Computing Division in the absence of the regular Chief and in 1855 was permanently placed in charge of this most important Division. In 1856 he was advanced to the grade of assistant, the highest in the survey after the superintendent.

The ability, zeal, indefatigable industry and vast mental resource so eminently